AMENDMENT TO THE SPECIFICATION

Please insert the following paragraph before page 1, line 11:

Title of the Invention

Please insert the following paragraph before page 1, line 14:

Cross-Reference to Related Applications
Not Applicable.

Field of the Invention

Please amend the paragraph beginning on page 1, line 14 to recite:

The present invention relates to a structure of an electrode for use as an anode/cathode in an electrolytic cell ~~as stated in the preamble of the following patent claim 1~~.

Please delete the following paragraphs beginning on page 1, line 19 to page 1, line 30:

~~Further the invention relates to a method for preparing said electrode structure.~~

~~The invention also relates to a use of the electrolytic cell including anode and cathode as mentioned above.~~

~~The invention relates to the technology concerning the production of oxidants and radicals which are used to oxidising and eliminating organic material in liquids, and organic materials on particles in liquids, and for destruction of bacteria, spores, micro organisms, algae and virus.~~

Please insert the following paragraph before page 1, line 32:

Background of the Invention

Please amend the paragraph beginning on page 2, line 13 to recite:

Another lesser-known method in use today involves that tantalum, iridium, or a mixture of these are rolled down to between ~~0,015~~0.015 and ~~0,035~~0.035 mm and is welded to a core for an anode

which is made of titanium, ~~aluminium~~aluminum or copper. By this method a frictional welding is used. The lifetime for these electrodes is longer than of the electrodes that are made by use of electrolysis. They tolerate substantially higher voltage and current. With these advantages in variables for electrolyses process, i.e., voltages from 0-380V and currents from 0-1000 Amperes, a mixture of oxidants is produced including a very high reactivity, power and possibility for functional balancing of the single oxidants (CL_2, $C10_3^-$, 0_3, 0_2, H_20_2, OH, C1OH, O), exceeding the effect of, and reduces the undesirable effect of oxidants from anodes produced by other methods.

Please amend the paragraph beginning on page 2, line 28 to recite:

The limitations for the preparation by these methods are the variation span in the mixture of alloys. For example it is known that platinum/iridium-alloys (Pt/Ir) including more than 20% iridium is difficult to roll down to the desired thickness. Today it is known that the alloy can be rolled down to 33 micron (~~0,033~~0.033 mm). Higher concentrations of Ir leads to even greater problems, and the prepared foil often becomes brittle. It is also ~~desireable~~desirable that the foil have a high degree of hardness in order to increase the mechanical resistance to wear and tear. Further the thickness of the foil is decisive in determining how much of certain oxidants is produced in a certain liquid with a given voltage and current. It is further known that for example pure platinum technically may only be rolled down to 15 micron (0.015mm). Below this thickness it is not possible to obtain a dense foil (without pores).

Please amend the paragraph beginning on page 4, line 26 to recite:

Furthermore it is known that US patent 6,342,151 comprises anodes/cathodes made of permeable conductive material selected from the group consisting of perforated plates, screens, wool, felt and weave made of stainless steel, ~~aluminium~~aluminum, copper, platinized titanium, mixed metal oxides, gold and gold plated steel. Also this electrode uses spacers to prevent ~~shortcut~~ short-circuits between anode and cathode when distance between said components ~~are~~ is small.

Please insert the following paragraphs before page 5, line 21:

Brief Summary of the Invention

Aspects of the present disclosure describe an electrode of electrically conducting material for use in an electrolytic cell. The electrode may include a spacer composed of a non-conductive material and permitting flow of liquid therethrough, and a conductive frame defining a plurality of liquid through flow openings. The conductive frame may have planar surfaces on either side and may be connectable to a current supply. A conductive perforated foil or a wire mesh is positioned adjacent to one of the planar surfaces of the conductive frame, and the spacer is positioned adjacent to the perforated foil or wire mesh to prevent electrical contact between the conductive frame and a second electrode.

In other aspects, the present disclosure describes a method of preparing an electrode as described above, wherein sheets of perforated foil or wire mesh are anchored to a frame surface of the conductive frame. The method may include subjecting a sheet of perforated foil or wire mesh to a stretch or tension force, and forcing against and fixing to the frame surface the sheet of perforated foil or wire mesh.

In further aspects, the present disclosure describes a method of using electrodes in an electrolytic cell. The method may include stacking and interconnecting a plurality of electrodes to form pairs of anodes and cathodes inside a pipe, causing liquid to flow through said pipe, processing the liquid flowing through the paired electrodes in the pipe, and applying a current to each pair of anode and cathode electrodes.

The invention relates to a method for preparing an electrode structure.

The invention also relates to a use of an electrolytic cell including anode and cathode.

The invention relates to technology concerning the production of oxidants and radicals which are used to oxidizing and eliminating organic material in liquids, and organic materials on particles in liquids, and for destruction of bacteria, spores, micro organisms, algae and viruses.

Brief Description of the Drawings

Fig. 1A shows a schematic plan view of an anode 1 of a high conductivity Cu (copper) frame 1 covered with a single wire mesh of a noble metal.

Fig. 1B shows a cathode frame 3 including a woven, knitted or plaited wire mesh 4 (for example of stainless steel 316L). The superior conductor frame 1 to which the wire mesh is fixed, is isolated with a molded oxidant-resistant isolator.

Fig. 1C shows the side section of the oxidant-resistant isolator by reference numeral 5.

Fig. 2 shows an anode of wires which are fixed to a superior conductor which is isolated.

Fig. 3 shows an anode of a foil which is fixed to a superior conductor which is isolated.

Fig. 4A shows an expanded view of a rectangular electrode structure.

Fig. 4B shows an expanded view of a circular electrode structure according to the invention.

Fig. 5 shows a section of an electrolytic cell (with only one set of an anode and cathode shown for simplicity) made of a wire, plaited, woven or knitted mesh with a separation mesh between the anode and cathode in order to prevent a short circuit contact. The liquid is processed in that it is conducted through the anode and cathode so that hydrogen is conducted out from the cathode and away from the anode.

Detailed Description of the Example Embodiments

Please delete the paragraph beginning on page 6, line 33 to page 7, line 2:

~~The device, the method and the use according to the invention are characterised by the features appearing in the characteristic clauses of the independent claims.~~

~~The further features of the invention are given in the dependent claims, respectively.~~

Please amend the paragraph beginning on page 7, line 23 to recite:

Further the invention is characterised in that the wires or anode ~~meshs~~meshes and cathode ~~meshs~~meshes may be joined close together without short circuit contact in that a separation mesh, membrane or coarse crossed squared mesh in a non-conductive oxidant resistant material, which is arranged between the anode and cathode in order to separate these to prevent a short circuit contact.

Please amend the paragraph beginning on page 9, line 29 to recite:

According to a ~~prefered~~ preferred embodiment of the invention, it is ~~prefered~~ preferred that each frame is covered by two layers of wire mesh, one layer ~~of~~ on each plane side of the frame. It is however sufficient that the frame includes only one wire mesh layer, as shown in figure 1A, 1B and 1C.

Please amend the paragraph beginning on page 10, line 1 to recite:

According to the most ~~prefered~~ preferred embodiment, a wire mesh or parallel threads, 12 and 14, respectively is bounded to each side of the conductor frame 10 by exposing it to a substantial tension force/pressure and possibly by applying heat and using a bonding agent, or by induction welding or laser welding ~~simoultaneously~~simultaneously with that wire or perforated foil ~~is~~ being kept under sufficient tension. Thus the wires or mesh covering the exposed area on each plane side of the conductor are stabilized. Possibly the wire mesh includes parallel threads where each tenth or twentieth thread is of tantalum while the others are platinum threads.

Please amend the paragraph beginning on page 10, line 13 to recite:

Onto one of wire layers 14 of the frame 10 or said separation wire mesh, a spacer foil 16 (of a polyvinyl choloride (PVC~~S~~) or polypropylene material) of a non-conducting material, and having the exact shape (plane view) of the frame 10, is positioned and anchored. Thus the openings 18 of the ~~separation wire mesh~~spacer foil 16 are aligned with the through flow openings 18 of the frame 10. Thus the through flow openings 18 of the frame 10 which are "covered" by the wire mesh 12, 14 is not covered by said spacer foil 16. The thickness of the frame 10 may be 5 mm, while the spacer foil 16 may have a thickness as low as ~~0,3~~0.3 mm (representing the separation between the anode and cathode surfaces). Thus the water/liquid through flow properties of the frame in use, is not obstructed.

Please amend the paragraph beginning on page 10, line 28 to recite:

Thus an electrode unit, for an anode or cathode, includes said conductive frame having a number of through flow openings 18, both plane sides of which being covered with the perforated plate, the wires (parallel threads or a wire mesh), and the spacer foil ~~18~~ 16 on one side only. Further the conductive frame (for a cathode or anode) 10 includes means 20 for connecting to adequate current supply (voltage and current).

Please amend the paragraph beginning on page 11, line 2 to recite:

In order to construct a single (the simplest) electrolytic cell, two electrode units as shown in figures 4A-B are mounted mutually close to each other in alignment, so that said spacer layer ~~18~~16, provides for the necessary distance (for example of ~~0,3~~0.3 mm) between the anode surface ~~14~~ of one electrode unit and the cathode surface ~~12~~ of the adjacent electrode unit.

Please amend the paragraph beginning on page 11, line 10 to recite:

It is ~~preferred~~preferred to cover the conductor frame (as being of stainless steel) 10 and the sections of the conductive wire (wire mesh) 12,14 covering said frame, with a non oxidizable material in order to protect against contact with the electrolyte, in a similar manner as shown in figure 1C.

Please amend the paragraph beginning on page 11, line 17 to recite:

An electrolytic cell consisting of a number of the abovementioned pairs of electrode units (up to 50 pairs), may have a circular, or ~~rectanuglar~~rectangular shape. A circular electrode unit may for example have a diameter of up to 1 meter, representing the water through flow of the unit. The electrolytic cell may be placed into a pipe conducting the water to be treated according to the invention, for example as shown in figure 5. When applying a sufficient voltage to the anode/cathode sets, the process water flowing through the unit (the openings 18) of the wire mesh of the unit, obtains a close reactive contact with the oxidants and radicals formed on the anode threads of the wire mesh.

Please amend the paragraph beginning on page 12, line 11 to recite:

Anode and cathode might be of identical material or different. In case of similar material DC power applied might be alternated to avoid scaling and uneven tear and wear. Anode size might each be more than 1 m diameter. Flow capacity might be from a few ~~litres~~ liters/hr in the smallest cells to more than 1000 ~~m3~~ m^3/hr in each of the largest cell. Typical current density at 316L anodes is 38 mA/~~cm2~~cm^2 provided Cl content at 5 ppm. For noble metals the above have been tested to 270 Amp at an anode area of ~~0,5 cm2~~ 0.5 cm^2.

Please amend the paragraph beginning on page 12, line 21 to recite:

The wire-mesh may be formed of individual wires mounted parallel to one another to the frame, or of individual wires that are woven, knitted or plaited or induction-welded to form the aforementioned mesh. ~~The distance between each paralell~~

Please amend the paragraph beginning on page 13, line 1 to recite:

It is ~~prefered~~preferred to direct the water to be processed through a mechanical particle extractor in order to remove all particles and organisms larger than the light aperture in the electrode.

Please amend the paragraph beginning on page 13, line 15 to recite:

The exposed gap between anode and cathode ~~have no~~does not need ~~for~~ conventional or further spacers, as spacing is provided by applying a foil, membrane or coarse of non conductive material of the same shape as the frame itself. The clearance might be as low as ~~0,3~~ 0.3 mm. This implies that by the invention, it is possible to obtain a high current density with a very low voltage, something ~~which involve~~ that easily exceeds the Law of Faraday~~Farraday easily is exceeded~~ without flow or current loss due to spacer and provides a desired production of reactive oxidants ~~is provided~~.

Please amend the paragraph beginning on page 13, line 26 to recite:

Another advantage by applying wire/mesh or perforated foil at both sides of the conductor frame is that it allows ~~mm2 uppscaling~~ mm^2 upscaling for extreme currents passing to the exposed area for electrolysis. A 5mm thick frame covered at both sides allows placement of a thin spacing frame at both sides where the cathode mesh/perforated foil can be placed close to the anode in a distance down to ~~0,3~~0.3 mm. With varying distances more than 3000 Amps can be passed through an electrode.

Please amend the paragraph beginning on page 14, line 1 to recite:

The present invention differs from existing electrolytic cells/processes in that one by means of a very low voltage, may obtain the necessary high current density of large area without this reducing the volume through flow of the liquid to be handled. This also implies that large volumes of liquid to be handled may be treated very cheaply. The volume capacity of the electrolytic cell is not changed in contrast to other electrolytic cells even though the distance between the anode and cathode is reduced from i.e., 5 cm to ~~0,3~~0.3 mm in that the same volume-liquid flow goes through the anode and cathode independent of the mutual distance between them.

Please amend the paragraph beginning on page 14, line 21 to recite:

The present invention differs from existing electrolytic cells/processes in that it is possible to obtain high current density, a low consumption of energy and a high through flow by volume of liquid, as the distance between the anode and cathode can be reduced to ~~0,3~~0.3 mm without this reducing the capacity of the electrolytic cell, so that it may be used with the iron conductivity in fresh water (surface water and ground water).

Please amend the paragraph beginning on page 16, line 33 to recite:

The structure shown in fig. 5 was used in control and verified experiments for treating the ballast water from ships and including sea water containing bacteria, micro organism, algae and spores.

The water including a high degree of pollution, was conducted through the cell once, as shown by arrows, with an amperage of 100 A. The result show that 100% of the abovementioned pollutants, including spores, where destroyed. An extrapolation of the results based on the experiments show that the required consumption of energy will be 5kWh in order to handle 2500 ~~m3~~m^3/h process water with an anode surface of ~~2,5~~ 2.5 m^2.

Please amend the paragraph beginning on page 17, line 10 to recite:

Similarly the structure as shown in FIG. 5 was used to prove oxidant production in fresh water. With an anode/cathode-distance of 1 mm and an anode of a precious metal mesh produced 0.5 ppm ozone during one through flow. Up scaling models show that 2500 m^3/h require 87 kWh with an anode surface of ~~2,5~~ 2.5 m^2.

Please amend the paragraph beginning on page 17, line 17 to recite:

The experiment was repeated with an anode mesh and cathode mesh of 316 L steel. During one through flow ~~0,91~~ 0.91 ppm ozone was produced in the drinking water with 80 V and 3 A.

Please amend the paragraph beginning on page 17, line 28 to recite:

This electrolytic cell was used for destruction of poly aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB) on particles in a sea water slurry. With a careful addition of electrolyte and circulation of the mixture during 20 minutes, the PAH-content was reduced by ~~99,6~~99.6% and the PCB-content was reduced by 76% based on relatively high concentrations. Some further examples of the invention are now presented.

Please amend the paragraph beginning on page 18, line 3 to recite:

An electrode stack as described in Figure 4B comprising 5 anodes and 6 cathodes all of 316 L steel and a total anode area of 1013 ~~cm2~~ cm^2 were assembled with a 1 mm spacer ~~as described in fig. 4~~. The liquid flow through the cell was at a rate of 10 l/min. Effluent was untreated drinking water from a surface source with salinity varying between ~~1,5~~1.5 and 5 ppm, and with high humic content. E-coli bacteria were added to the water at a concentration of 560.000

bacterias/ml. Passed once through the cell with current 20 Amp showed a total disinfection ~~efectivness~~effectiveness in all samples taken after ~~treathment~~treatment. That is sample series taken between 2 and 20 minutes after passed trough the cell.

Please amend the paragraph beginning on page 18, line 16 to recite:

The same samples were ~~analysed~~ analyzed for trihalomethanes (Cloro-organic and bromoorganic compounds). These samples showed results in the range of 0.9~~-2,5~~ 2.5 ppb. This is extremely low compared to ~~elorination~~ chlorination of water. Total count of bacteria was more than 10 log 3 by applying ~~18,5~~ 18.5 Amp.

Please amend the paragraph beginning on page 18, line 30 to recite:

Produced water from oil and gas production containing PAH, Hydrocarbons, Phenols and benzene, ethylbenzene, toluene and xylene ~~BETEX~~ (BETX) with significant concentration was passed through 1 noble metal anode of knitted wire cloth and 2 cathodes as shown in FIG. 4B. Amperage was 300 Amp and anode area 180~~-cm2~~ cm^2. The flow rate was 180 l/min. Phenols were reduced from 1580 microgram/l to 0.51 microgram/1. PAH 16 was reduced from ~~34,7~~34.7 microgram/l to ~~3,92~~3.92 microgram/l. Non-polar dissolved hydrocarbons (NPD) was reduced from 114 microgram/l to 3.92 microgram/l total extractable organic matter (TEOM) (C10-C40) was reduced from 16 mg/l to ~~2,41~~ 2.41mg/l.

Please amend the paragraph beginning on page 19, line 6 to recite:

A contaminated fluid from a oil refinery containing 1600 ppm~~-H2S~~ H_2S, 2-3% Phenols and 2900 ppm Ammonium was processed through two noble metal wire mesh anodes stacked with 3 cathodes of 316 L steel mesh. Anode ~~arrea~~area total was 225 ~~cm2~~ cm^2. Current was 300 Amp. Flow 140 l/min. Cl-content was 2% NaCl. After batch ~~proccesing~~processing a volume of 40 l for 15 minutes the H_2S was oxidized to 0 ppm and further 15 minutes processing resulted in ammonium content of 3 ppm and Phenol content of 300 ppb. During processing pH was controlled by additives.

Please amend the paragraph beginning on page 19, line 17 to recite:

250 g Drill cuttings from oil and gas industry was processed through an electrode under conditions as described in EXAMPLE 4. The cuttings ~~was disperged~~ were dispersed into 221 of effluent containing 6 % NaCl. Scope was to remove Hydrocarbons from particles. Initial content of ~~7,62~~7.62% total Hydrocarbon vas reduced to 1.32 % in an hour processing.

Please amend the paragraph beginning on page 19, line 24 to recite:

Deep blue textile dying wastewater was passed through an anode of noble metal threads stretched across a 5 inch diameter ~~sircular~~circular anode conductor frame so that the area of anode only was ~~0,5 cm2~~ 0.5 cm^2 total. The 2 cathodes was wire mesh of 316L steel. 20 l was batch ~~proccesed~~ processed with flow 180 l/min through the electrode. Volume 20 l. NaCl content 5%. Current was 270 Amp. In 25 to 35 seconds the waste water became blank.

Please insert the following paragraphs after page 19, line 31:

The device, the method and the use according to the invention are characterized by the features appearing in the characteristic clauses of the independent claims.

The further features of the invention are given in the dependent claims, respectively.